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ABSTRACT

This report describes aspects of the professional engagement of American teachers and examines relationships between professional engagement and teaching practice, including instruction involving computer use. Professional engagement is measured by: the frequency that teachers had informal substantive communications with other teachers at their own school; frequency and breadth of professional interactions with teachers at other schools; and breadth of involvement in specific peer leadership activities. Using these measures of professional interactions and activities, teachers were divided into four groups, from the most- to the least-professionally engaged using the following categories: Teacher Leaders (2%), Teacher Professionals (10%), Interactive Teachers (29%), and Private Practice Teachers (58%). Findings indicated that the more extensively involved teachers were in professional activities, the more likely they were to: (1) have teaching philosophies compatible with constructivist learning theory; (2) teach in ways consistent with a constructivist philosophy; and (3) use computers more and in exemplary ways. Results also showed that professionally engaged teachers were somewhat more experienced than others and had made more investments in their own education, but that they taught a representative group of students. Although professionally engaged teachers who taught in more privileged environments used computers more than those in high-poverty schools, those differences were largely explained by differential access to technology at school, at students' homes, and at teachers' homes. Three tables appended include: subscale scoring by category of professional engagement; highly constructivist teachers and exemplary computer users by professional engagement and type of school sample; and effects of school-based access to technology on the difference in teachers' involvement in computers between high-socio-economic status and low-socio-economic status schools, for professionally engaged teachers and other teachers. (AEF)

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Teacher Professional Engagement and Constructivist-Compatible Computer Use

Henry Jay Becker
Margaret M. Riel

Teaching, Learning, and Computing: 1998 National Survey

Report #7

Center for Research on Information Technology and Organizations
University of California, Irvine

And

University of Minnesota

December, 2000

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ABSTRACT

This report describes a number of aspects of the professional engagement of American teachers. It also examines relationships between professional engagement and teaching practice, including instruction involving computer use. We defined professional engagement as a teacher taking effort to affect the teaching that occurs in classrooms other than his or her own. We measured professional engagement by (1) the frequency that a teacher had informal substantive communications with other teachers at their school, (2) the frequency and breadth of professional interactions with teachers at *other* schools, and (3) the breadth of involvement in specific peer leadership activities—mentoring, workshop and conference presentations, and teaching courses and writing in publications for educators. Using these measures of professional interactions and activities, we divided teachers into four groups from the most- to the least-professionally engaged using the following categories: Teacher Leaders (2%), Teacher Professionals (10%), Interactive Teachers (29%), and Private Practice Teachers (58%).

We tested the hypothesis that teachers who regularly participate in professional interactions and activities beyond their classroom teach in different ways than teachers who have minimal contact with their peers or profession. In particular, we examined whether the professional engagement of teachers correlated with a specific philosophy, with types of instructional practices linked to philosophies, and with frequency and type of computer use. We also showed how professionally engaged teachers distribute by subject area, school and community characteristics (e.g., student SES and ethnicity), and in their own educational and teaching background.

We found that the more extensively involved teachers were in professional activities, the more likely they were to (1) have teaching philosophies compatible with constructivist learning theory, (2) teach in ways consistent with a constructivist philosophy, and (3) use computers more and in exemplary ways. We found that professionally engaged teachers were somewhat more experienced than others and had made more investments in their own education but that they taught a representative group of students—they were not less likely present in schools serving disadvantaged students nor were they more likely to be assigned to classes of higher ability students. Finally, we found that although professionally engaged teachers who taught in more privileged situations did use computers more than professionally engaged teachers in high-poverty schools, those differences were largely explained by differential access to technology—at school, at students' homes, and at teachers' homes. Given sufficient access to computers, professionally active teachers will use them in exemplary ways, and given their greater involvement in leadership activities and informal collaborations with peers, teacher leaders are in a position, with sufficient authority and time, to help other teachers move towards being more accomplished users of computer technology.

TEACHER PROFESSIONAL ENGAGEMENT

Teachers' Personal Definition of Their Role

Teachers vary in how they conceptualize their role–their duties and responsibilities as teachers. Some teachers view their work as taking place solely within their classrooms in what is essentially a private, individual practice. They are content to let educational decisions about curriculum, policies or standards be made by outside experts, and they accept that different teachers choose to teach in ways that they themselves believe are ineffective or wrong. Instead, they focus on trying to be the best teacher they can be with the students in their own classroom. Others view their responsibilities as extending beyond classroom teaching to include participation in the larger community of educators and administrators. They see their role as trying to help other teachers be more successful and to influence how teaching occurs in other places. Although few teachers see teaching exclusively in one way or the other, it may be useful to think of this contrast as a continuum from private to professional practice. How teachers define their role will determine how they spend their limited time both in and beyond the classroom.

Private Practice

Traditionally, the job of teaching involved accepting sole responsibility for the education of a small group of students over some period of time, often working alone. As schools grew in size, the organization shifted to graded classrooms for younger students and subject-specific courses for older students, and to having more teachers and students in the same school building. But the structure of one teacher to each class of 15 to 35 students has remained remarkably uniform.

Many teachers use their autonomy to implement their personal theories about teaching and learning in their subject-area, while others use the closed door to hide their difficult struggle with the complexity of teaching. For the latter group, to ask for or offer help risks assumptions of incompetence or interference with the autonomy of others. Teachers with a private orientation have little time for meetings, conferences, or other forms of professional engagement. Teachers employ the textbooks and other teaching resources which they are given or which they gather themselves, and orchestrate their own instructional practices without significant input from others. They may do this because of perceived disagreements between their own perspective and those of their peers or because of a sense that the norms of their craft do not permit admitting that one needs help from peers in order to do one's work. In either case, their choice is to engage in a private practice.

Professional Practice

A contrasting orientation to teaching sees it as a collective endeavor rather than a private practice of individual teachers. Teachers today are expected to prepare all students to reach significantly higher academic standards than have ever been attempted in this country (Murnane & Levy, 1996). In this situation, an individual teacher can never know enough to warrant closing the classroom door. Collegiality is the logical inverse of privacy and personal control (Little, 1993).

We refer to the opposite pole of a teacher's role orientation, not as "collaborative" but as "professional." Teachers with a professional work orientation not only try to help other teachers do a better job in their classrooms, but they also see their responsibility in terms of the larger community of educational practitioners (Glazer, 1999). Their concern about what happens in other classrooms becomes part of their own definition of being successful. For example, when teachers with a professional work-orientation experience pressure from school, district, or state recommendations that contradict their studied beliefs about good teaching, they work collectively to formulate a collective but substantive response rather than expecting each teacher to resolve the conflict individually.

Teachers who adopt a collaborative stance toward teaching are more likely to build a professional identity than those engaged in private practice. This professional identity includes publishing papers, offering workshops and speaking at conferences. They view their relationship to other educators within and beyond the school as an important determinant of the quality of student learning in the classroom (Glazer, 1999).

Teacher Role Orientation as Patterns of Interaction with Other Teachers

These two contrasting orientations will affect the way that teachers interact with their colleagues. In this study, we look at the nature of teacher interactions with other teachers at the same school, with teachers at other locations, and with the larger educational community—particularly interactions that suggest professional leadership in that community. We will use these markers to identify teachers who view teaching in professional terms and contrast such teachers with those whose lack of interactions with other teachers suggest a more private practice. We then examine how the presence or absence of social relationships within and beyond the school affect teachers' own classroom teaching and, in particular, their use of computers.

Data Source

Our data on teachers' role orientation, beliefs about teaching, and teaching practices comes from a national survey, conducted during the Spring of 1998, that focused on the relationship between teacher pedagogy and their use of computers in teaching. The study was funded by the National Science Foundation with additional funds provided by the Office of Educational Research and Improvement, U.S. Department of Education. Called Teaching, Learning, and Computing—1998 (TLC), the survey involved questionnaire responses from three different samples of schools—a national probability sample of schools (655 participated of 898 sampled); a purposively drawn sample of schools with the greatest per-capita computer technology (110 schools participated), and a purposively drawn sample of schools that were participating in some way in substantial educational reform efforts, either self-initiated or as part of one of 50 different national or regional reform programs (450 schools). Within each school, the TLC survey collected data from the principal, the school technology coordinator, and a probability sample of teachers. The teachers were selected in a way that disproportionately over-sampled those who made substantial use of computers, who had students do project work, and who emphasized higher-order thinking in their teaching. However, all analyses use weights that compensate for differential sampling rates of different types of teachers so that the results can be seen as coming from a representative sample of teachers at the schools surveyed.

The teachers whose responses are described in this report number 4,083, including 2,251 in the national probability sample of schools. The teachers are those who taught classrooms from the 4th through the 12th grades in all subjects except physical education and special education. The teachers completed 20-page survey instruments. Some survey questions were asked to subsets of respondents (four different overlapping questionnaire versions were used), so some of the data was not based on the full sample surveyed. The teacher respondents are 69% of the teachers originally sampled; and the schools participating include 75% of the schools initially selected.

Defining Professional Engagement From Survey Responses

The four-category measure, level of Professional Engagement, used in this report is based on teachers' responses to three multi-part survey questions. The first question dealt with two kinds of *within-school informal interactions* a teacher might have—discussions with other teachers about teaching issues; and their experience in observing other teachers' classroom instruction as well as being observed by these same teacher-peers. The second question dealt with *beyond-school contacts*—sustained professional

contact with teachers at other schools through committee work, multiple conference attendance, and electronic mail. The third question concerned the teacher's recent involvement in specific *leadership* activities—mentoring other teachers, presenting at workshops, teaching at universities, and publishing. For each of the three survey questions, criteria were defined to indicate "high" and "medium" levels of engagement in that particular area. Teachers who scored "high" in all three areas (within-school, beyond-school, and leadership) we designated as "Teacher Leaders." Those who had scores of at least "medium" in each area we designated "Teacher Professionals." The remaining teachers were designated either "Interactive Teachers" or "Private Practice Teachers" based on their combined score on the three survey-question-based indices. In the following section, we discuss teachers' responses to each of the three multi-part survey questions, and then show the kinds of responses that placed teachers into one or another level of Professional Engagement.

Within-School Interaction

A teacher's Within-School Interaction was defined as the average frequency that the teacher reported having each of six types of interactions with other teachers at their own school. Those interactions included discussions about teaching methods, project ideas, subject-matter issues, technology (Table 1a), and informal observations of another's or one's own teaching (Table 1b).

TABLE 1A: FREQUENCY OF TEACHER INFORMAL DISCUSSIONS WITH OTHER TEACHERS AT THEIR OWN SCHOOL

How often do you have the following types of interactions with other teachers at your school?	% Seldom/ Never	% Several/ month	% 1-3/ week	% Almost Daily	% Total
Discussions about how to teach a particular concept to the a class	21	44	22	13	100
Discussions about ideas for student or group projects	20	45	23	12	100
Discussions of different views about an issue within our common subject area (e.g. science)	23	44	21	12	100
Discussions about computer software or the Internet	26	41	23	10	100
Discussions on *any* of the above topics	6	37	32	23	100

Sample: Probability sample.

TABLE 1B: FREQUENCY OF CLASSROOM OBSERVATION

How often do you have the following types of interactions with other teachers at your school?	% Seldom/ Never	% Several/ month	% 1-3/ week	% Almost Daily	% Total
Visits to another teacher's classroom to observe teaching	78	16	4	1	100
Informal observations of *my* classroom by another teacher	79	17	2	2	100

Sample: Probability sample.

For each one of the four types of informal *discussions* that we asked about, about one-third of all teachers reported having at least weekly discussions, and 10% reported having daily interactions around these topics. For example, 12% of teachers said they had discussions with other teachers about ideas for student or group projects "almost daily," while another 23% said they had those kinds of discussions "1 to 3 times per week." (See Table 1a.) The same teachers who discussed one of the four topics also tended to discuss the others.[1] Thus, while one out of six teachers (16%) said that they had informal discussions at least weekly about three or even all four topics (data not shown in Table 1a), a substantial minority of teachers (43%) indicated that they didn't have weekly conversations about *any* of them.

[1] Correlations were particularly high among teaching about concepts, ideas for group projects, and professional issue s in their subject matter, ranging between .54 and .71.

In contrast to the reasonably common practice of holding informal discussions on substantive topics, only a small minority of teachers regularly observe one another's teaching. Slightly more than one teacher in five (21%) reported observing other teachers at least "several times per month" and a similar number reported being observed that often themselves. Observations occurring as often as weekly was reported by very few teachers (4 to 5 percent).

We combined teachers' responses to the "informal discussion" interactions and the "classroom observation" interactions (each with responses coded 1 to 4) to compute an average measure of Within-School Interaction. A teacher whose six types of informal interactions averaged halfway between "several per month" and "one to three times per week" was classed as "high" in Within-School Interaction, and this designation was one of the three standards for being defined as a Teacher Leader. A "medium" score, leading to the designation of being a Teacher Professional, was based on an average answer of "several per month."

Overall, 13% of 4th through 12th grade teachers in the probability sample met the "high Within-School Interaction" criterion and 27% other teachers met the less rigorous "medium" criterion. However, because teachers who collaborate within their school don't necessarily collaborate beyond their school and don't necessarily engage in leadership activities, only a small minority (16%) of teachers who met the "high" criterion for Within-School Interaction also met parallel standards on the other two aspects of teacher professional engagement and thus became classified as Teacher Leaders. Similarly, only about one-fourth of those who met the less rigorous "medium" standard in terms of their Within-School Interactions also met at least a medium standard in both of the other two aspects of professional engagement.

Beyond-School Contact

The second survey question used to define levels of Professional Engagement asked teachers about their interactions with teachers at schools other than their own (Table 2). "Beyond-School Contact" was defined in terms of three types of cross-school contacts that teachers might have: attending workshops, participating on committees, and emailing teachers at other schools. We used frequency standards for each type of activity: attending workshops with teachers from other schools at least 3 times since September; going to 3 or more committee meetings with teachers from other schools; and using electronic mail with teachers at other schools at least a half-dozen times. To be considered "high" on Beyond-School Contacts, two of those criteria needed to be met; a "medium" designation was given to teachers who met only one criterion.

The vast majority of teachers attended workshops or conferences at some point during the year, and nearly one-half of those that did, attended at least three of them during the roughly six to eight months that transpired between the start of the school year and the point at which they answered their questionnaire. Fewer teachers participated on district or other-level committees, and fewer still used electronic mail to communicate with teachers from "other places." Of the teachers in the probability sample, 42% met the workshop attendance criterion, 28% met the committee meeting criterion, and 16% met the electronic mail criterion. A majority of the teachers (53%) met at least one beyond-school contact criterion and 26% met two or three. Teachers who were rated "high" on the Within-School Interaction index were roughly twice as likely as teachers who met neither "high" nor "medium" standards for Within-School Interaction to meet each of the three Beyond-School Contact criteria.

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TABLE 2: FREQUENCY OF PROFESSIONAL CONTACT WITH TEACHERS AT OTHER SCHOOLS

	% Not so far this year*	% 1-2 times	% 3-5 times	% More Often
A workshop or conference with teacher from other schools	14	44	29	13
A committee meeting with teachers from other schools	45	27	20	8
Electronic mail with teachers from other places	61	14	9	16

Sample: Probability sample.
*The time period represented is most of a school year. Teachers completed surveys between March and June of 1998.

Leadership

The third survey question asked about the teacher's involvement over the past three years in six types of leadership activities within the profession, including mentoring other teachers (2 measures), giving workshop presentations (2 measures), teaching college-level courses, and publishing. Overall, 19% of all teachers engaged in at least three of these six activities—qualifying them to be considered as possible "Teacher Leaders." (See Table 3.) Another 18% met the "medium" standard in this area (2 of the 6 activities).

TABLE 3: PERCENT OF TEACHERS ENGAGING IN SPECIFIC LEADERSHIP ACTIVITIES

In the past three years, which of these experiences have you had?	% Yes
Informally mentored another teacher for most of ayear	38
Formally assigned to mentor another teacher for most of a year	23
Gave a workshop or talk for at least 25 teachers	35
Gave workshops for teachers on at least 5 occasions	15
Taught a college-level course for credit	10
Published an article for professional educators	5
Three or more of the above	19
Two or more of the above	37
None of the above	40

Sample: Probability sample.

One might argue that the leadership activities discussed in this one survey question provides a sufficiently comprehensive portrait of teacher peer leadership. However, teachers who only gave workshops, taught classes, and published articles, and who did not engage in frequent interaction with teacher peers at their own school or elsewhere, provide a rather limited, and abstract, form of leadership. Our measure of Teacher Leaders required activity in response to all three survey questions. It turned out that only 11% of those who met the "high" criterion for leadership (3 or more of the 6 types of leadership activities during the past three years) qualified as Teacher Leaders; the rest were either not sufficiently involved in two of the Beyond-School Contacts (conference attendance, committee work, or electronic mail communication with teachers in other places) or not sufficiently involved in informal substantive discussions and classroom observations at their own school. However, another 28% of those who were "high" in Leadership qualified for the second level of Professional Engagement (Teacher Professionals), by meeting the "medium" standard in each of the other two areas. Thus, overall, about 40% of the teachers who participated in several types of leadership activities also were engaged in both Within-School Interactions and had Beyond-School Contacts sufficient for them to be classified as "Professionally

Engaged Teachers"—teachers who met either the standards for a "Teacher Professional" or the more rigorous standards for a "Teacher Leader."

Teacher Leaders vs. Teacher Professionals (and Other Distinctions Among Categories of Professional Engagement

The differences in peer interaction and leadership behavior between the top two categories of Professional Engagement, Teacher Leaders and the Teacher Professionals, are not as great as the differences between both of those groups and the remaining teachers. In both groups, these are teachers who demonstrate a sense of their responsibility to engage in a regular interchange with an educational community beyond their classroom students. There is a difference in the forms and frequencies of their activities but the overall evidence points to a professional stance. Together, we refer to both categories of teachers as Professionally Engaged Teachers.[2]

There were also important differences among the teachers who did not meet "medium" standards on all three Professional Engagement measures and we indicated this by dividing this group into two as well. Teachers who were at the mean or higher on a combined index of all three survey questions, we termed Interactive Teachers. Teachers with scores below the mean, we termed Private Practice Teachers. All Interactive Teachers, as it turned out, scored medium or higher in at least one of the three areas and nearly 80% of them scored "high" in at least one area. However, in at least one area, Interactive Teachers failed to meet a medium standard. Thus, their teaching practice may involve professional dialog with teachers at their school, or collaboration beyond their school, or leadership activities, but not all three. On the other hand, almost half of all Private Practice Teachers did not meet *even medium standards in any area* and 85% of them did not meet a "high" standard in any area. Appendix Table A-1 provides details about how each of the four groups of teachers scored in each of the three areas.

Characterizing Sample Teachers by Level of Professional Engagement

In summary, then, using a set of three survey questions and their 15 different empirical indicators, we divided teachers into four categories representing increasing levels of Professional Engagement. Overall, only 2% of teachers in our nationally representative (probability) sample met the criteria for being a Teacher Leader. Another 10% fell into the Teacher Professional Category. In contrast, more than half (58%) (partly by definition, but confirmed by the nature of their reports of their teaching practice) were classed as Private Practice Teachers. (See Table 4.) The remaining 29% of probability sample teachers fall into the intermediate category, which we term Interactive Teachers. Such teachers *do* engage in substantive interaction with other teachers, but do *not* do so both in school and beyond school *and* in a way that their professional leadership is publicly visible.

[2] This can be shown by the fact that more than 90% of the Teacher Professionals exceeded the minimum standard for falling into that category. That is, to be classified as a Teacher Professional, a teacher had to obtain at least a "medium" score in all three aspects of Professional Engagement—Within-School Interactions, Beyond-School Contact, and Leadership Activities. More than 9 out of 10 of such teachers, though, scored "high" in at least one area and nearly half (49%) scored high in two of the three areas. The only ways that Teacher Leaders and Teacher Professionals differed more than minimally from one another were in terms of how frequently other teachers observed their teaching (and how frequently they observed other teachers), whether they had given workshops to teachers on at least 5 occasions during the past three years, whether they had attended at least 3 district committee meetings since September, and how frequently they had discussed "how to teach a particular concept" with another teacher at their school. In each case, the Teacher Leaders had higher scores—that is, they had done these things more often or were more likely to have done them.

TABLE 4: CATEGORIES OF PROFESSIONAL ENGAGEMENT

Level of Professional Engagement	Description of Professional Engagement	Weighted Percent & Raw N*	
		Probability Sample Only	Full TLC Sample
Teacher Leaders	Teachers meeting the highest standards on Within School Interactions, Beyond-School Contact, and Leadership Activities.	2% (70)	3% (176)
Teacher Professionals	Teachers meeting somewhat more modest standards on all three dimensions of Professional Engagement, and generally meeting the highest standards in one or two areas as well.	10% (311)	12% (627)
Interactive Teachers	Teachers who spend some time interacting with or leading their peers, either in or beyond their school, but do not meet standards on all three dimensions.	29% (724)	30% (1331)
Private Practice Teachers	Teachers who do not interact substantially with their colleagues near or far.	58% (1109)	55% (1870)

*The number of teachers shown is the actual number of teachers surveyed who placed into that category. The percent shown is the weighted percentage of all studied teachers, taking into account the sampling probabilities for each teacher and each school. The rightmost column combines teachers from the probability sample of schools and the selected reform -involved and high-technology schools in proportion to their relative sample size.

To give the reader more of an idea of how these four levels of Professional Engagement translate to actual teachers' reported behaviors, the following four brief portraits of individual teachers, selected at random from the sample at each level, may be helpful.

Teacher A, who falls within the Teacher Leader category, is a 47 year-old African-American woman who teaches a self-contained class at a predominantly minority public elementary school in Alabama. Although not attending a selective college, she obtained a high GPA during college, and has recently taken at least one course for credit. She reports that at least once a week, she observes another teacher's classroom and in turn is observed by other teachers. Equally often, she has discussions with other teachers at her school about how to teach a particular concept and about subject-matter content. Less often, but still several times per month, those discussions include ideas for student or group projects and discussions about technology. Teacher A is also active in committee work, participating in workshops and district committee meetings on at least a monthly basis, and has contacts with teachers in other places through electronic mail. In terms of leadership, in the past three years she has given a workshop or conference talk for at least 25 teachers and has both formally and informally mentored another teacher.

Teacher B, who was classified as a Teacher Professional, is a 53 year-old high school vocational education teacher whose courses deal exclusively with computer applications. Over his career, he has taken a great deal of college-level coursework, having not only a master's degree, but 30 units beyond that. Like Teacher A, our illustrative Teacher Leader, Teacher B has a high level of interaction with teachers at his own school, in a small town in western Massachusetts. He not only has daily discussions with other teachers about computers, but he has at least weekly discussions with them about teaching concepts, and he visits other classrooms to observe teaching that often as well. Like Teacher A, he participates on district committees and attends workshops very frequently. He, himself, has presented at workshops on at least 5 occasions over the past three years and informally mentors other teachers. However, his own classes are not observed as often as those of Teacher A nor does he have a formal mentoring assignment in his school. He reports some e-mail contacts with teachers at other schools, but does not e-mail other teachers as often as Teacher A does.

Teacher C is an example of an Interactive Teacher, less professionally engaged than either Teachers A or B but not a Private Practice Teacher either. Teacher C is a young teacher, 25 years old, in his second year

of teaching middle school science. He attended a relatively unselective college and had a modest GPA but is still taking courses for credit. Although he seldom observes another teacher's classroom, he reports frequent informal contacts with other teachers—observations of his own teaching and discussions about teaching methods, computers, and subject-matter issues all on a weekly, if not daily, basis. He has attended several conferences and workshops during the school year, but does not participate on committees or engage in any of the leadership activities which we asked about. Of course, he is quite a newcomer to the teaching profession, and his active involvement with other teachers at his school may foreshadow increasing professional engagement as his career proceeds.

Our final exemplar, Teacher D, was classified—along with a majority of all teachers in the survey—as a Private Practice Teacher. Teacher D is a 45 year-old woman, a high school mathematics teacher with more than 20 years of teaching experience. She attended a moderately selective college as an undergraduate, but received modest grades and does not have an advanced degree nor many post-BA units of credit. In terms of her Within-School Interactions with other teachers, she reports rarely observing other teaching or being observed herself. Although she does have some informal exchanges with other teachers at her school, these are primarily personal ones rather than discussions about issues related to teaching. Outside of school, she has attended workshops frequently, but does not participate on committees nor does she communicate with other teachers by e-mail. This very experienced teacher reports *none* of the leadership activities we asked in the survey—mentoring, presenting at workshops, teaching college courses, or publishing. Thus, except for frequent workshop attendance, there are few indications that Teacher D is intellectually involved with her teaching peers, despite her obviously extensive classroom teaching experience.

A Note on the Probability and Purposive Samples of Schools in TLC

Given that nearly one-half of the teachers in the Teaching, Learning, and Computing survey sample were drawn from outside of the probability sample (i.e., 45% were from schools participating in instructional reform programs or in schools with a substantial density of computer technologies), it is not surprising that Professionally Engaged Teachers constitute a somewhat larger percentage of teachers in the full sample than in the probability sample alone (15% vs. 12%; see Table 4). Although so far this paper has focused on the probability sample of teachers, most of the remaining data draws from both the probability and purposive samples in our database—thus disproportionately including teachers from schools involved in instructional reform programs and from schools with a high level of computer technology. The reason for combining both samples of teachers into a single analysis was to enable us to divide the sample into small segments (e.g., by subject taught) and still be able to identify differences between higher and lower levels of Professional Engagement. Where patterns appeared to sharply differ between the probability and purposive samples, we retreated to the data on the probability sample alone.

HOW PROFESSIONALLY ENGAGED TEACHERS DIFFER FROM PRIVATE PRACTICE TEACHERS

The remainder of this report examines differences and similarities among the four types of teachers defined by their level of Professional Engagement. Primarily, we are looking "backwards," at differences in teachers' own backgrounds, teaching responsibilities, and teaching philosophies that might account for their different role orientations. We also look "sideways" to see whether Teacher Leaders teach differently than other teachers and whether they use computers differently in their teaching. And we examine students' differential access to Professionally Engaged Teachers by relating student socio-economic and achievement variables to the professional engagement of the teachers who teach them.

Personal Characteristics and Teaching Experience

Teacher Leaders, on the average, are about 5 years older and have had 5 years more teaching experience than the other teachers in the sample. While it makes sense that veteran teachers should be providing leadership, this finding runs contrary to assertions often made about teachers, such as that older teachers, educated at a time when teaching was seen as a more solitary activity, might be less likely to be involved in professional activities. Clearly, that is not always the case. (See Table 5.)

In the overall sample, 66% of the respondents were female. However the most professionally engaged teachers—Teacher Leaders and Teacher Professionals—were even more likely to be female (74%).

TABLE 5: PERSONAL BACKGROUND DATA

Professional Engagement	Mean Age	Mean Years of Teaching Experience	% Female
Teacher Leaders	48.0	19.5	74
Teacher Professionals	44.9	15.9	70
Interactive Teachers	43.5	15.2	65
Private Practice	42.6	13.7	65
All Teachers	43.3	14.6	66

Sample: Probability and purposive samples.

Educational Background

Although relatively few teachers themselves graduated from "selective" colleges and universities (i.e., those whose entering freshman scored above 1100 on SATs), Teacher Leaders were more likely to do so than other groups of teachers (13% vs. 8%). In addition, the most professionally engaged teachers maintained higher grade point averages in college and were more likely to have graduate degrees than the rest of the teachers in the sample. When we combine four educational background variables into an index of "Educational Investment,"[3] we find that teachers with greater professional engagement have substantially higher average educational investment themselves. For example, the average Teacher Leader's Educational Investment score (0.49) would place him or her in the 69th percentile nationally (See Table 6, z-scores). Teacher Professionals are also more educated than typical teachers in the sample (averaging in the 60th percentile). Private Practice Teachers are, in contrast, less well educated (45th percentile). Although there are likely to be many very good teachers who are isolated in their classrooms, this data suggests that those who close the door are teachers with less academic preparation than those who are engaged in professional activities.

TABLE 6: PERSONAL BACKGROUND DATA

Professional Engagement	% Arts and Sciences Major in College*	% Graduated from selective college	% Undergrad GPA 3.5+	% MA or higher	% took credit college course in past 2 yrs	Educational Investment Index z- score
Teacher Leaders	48	13	50	64	50	0.49
Teacher Professionals	50	8	39	59	60	0.26
Interactive Teachers	53	7	34	50	54	0.07
Private Practice Teachers	52	8	28	42	49	-0.12
All Teachers	52	8	32	47	52	0.00

Sample: Probability and purposive samples.
* Not part of Educational Investment index.

[3] The variables were: college selectivity (freshman entering SAT scores, 1978); undergraduate grade point average (6 ordinal categories); highest degree obtained (6 ordinal categories including a specified number of "units" beyond a degree); and "year of most recent course taken for credit" (5 ordinal categories). Each variable was divided by its standard deviation thereby contributing equally to the overall measure.

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Teaching Responsibilities

Teacher Leaders and Teacher Professionals were distributed proportionally across subject areas and grade levels in the national probability sample with one exception: Proportionately more computer education teachers met the criteria for these two highest levels of Professional Engagement (see Table 7). Thus, it appears that teachers who teach computer classes, as a whole, are more engaged in a collaborative culture than teachers from other subject areas.

The Teacher Leaders and Professionals who were identified from the purposive sample—the reform program schools and schools with very high levels of technology—showed more variation by subject area. These schools appear to have proportionally more Professionally Engaged Teachers in other applied secondary subjects *besides* computer education (e.g., business and vocational education), and also in elementary self-contained classrooms.

TABLE 7: PERCENT TEACHER LEADERS AND TEACHER PROFESSIONALS BY SAMPLE TYPE AND SUBJECT TAUGHT

	% Teacher Leaders and Professionals, Probability Sample	% Teacher Leaders and Professionals, Reform/Tech (Purposive) Sample	% Teacher Leaders and Professionals, Both Samples
Secondary			
Computer Education	22	24	23
Business Education	13	34	19
Vocational	11	30	18
Social Studies	13	13	13
Science	11	18	15
English	12	13	12
Other Secondary	13	22	17
Math	12	11	11
Elementary			
Self-contained classrooms	13	25	17
Other Elementary	12	19	13
All Teachers	12	18	15

Philosophy of Teaching

As a group, Professionally Engaged Teachers seem philosophically different from Private Practice Teachers. Teachers' responses to individual TLC survey questions suggest that Teacher Leaders and Teacher Professionals are more likely than other teachers to see good teaching in terms of facilitating student inquiry rather than directly transmitting knowledge. They are more likely to emphasize student engagement in learning and the "meaningfulness" of content than to be concerned about disseminating a specific externally mandated curriculum to unmotivated students. In fact, across a large number of survey questions about teaching philosophy, there was such a coherence in the differences in beliefs about good teaching between Professionally Engaged and Private Practice Teachers that one can truly say these groups espouse quite different teaching philosophies.

Educational Philosophy Index: Traditional Beliefs vs. Constructivist Beliefs

Our measure of teaching philosophy comes from three survey questions, incorporating 13 individual prompts.[4] In one question, teachers were asked to compare the likely effects on student learning of two teachers' contrasting approaches to classroom discussion. One approach represented traditional teacher-directed questioning based on prior reading; the other represented teacher-led discussion that provoked

[4] For more detailed information on teachers' responses with respect to the teacher philosophy index, see TLC Report #4 (Ravitz, Becker, and Wong 2000) —available online at www.crito.uci.edu/tlc.

questions from the students themselves which the teacher then reflected back to them for further research. A second set of four questions presented paired comparisons of contrasting teaching philosophies. Each item presented a hypothetical personal statement of beliefs around issues such as curriculum coverage versus "meaning-making" and alternative classroom activity patterns (teacher-directed versus varying group activities).[5] The third question involved a set of seven agree vs. disagree statements (6-point scales) including explaining the need for direct instruction in terms of the importance of providing students with background knowledge; arguing for the value of building instruction around problems with "clear, correct answers and...ideas that most students can grasp quickly"; and valuing student freedom of movement in the classroom for facilitating student initiative to learn.

An index was created by taking the mean of these 13 prompts, after equalizing item standard deviations (effectively creating standard scores for items). The alpha reliability for this index was .83, suggesting that a strong single dimension underlies these specific beliefs about good teaching. We term that dimension a "teaching philosophy," with a contrast between a "transmission" view of good teaching (direct instruction and repetitive skills practice around a fixed curriculum) and a "constructivist" view (knowledge construction through collaborative projects, and problem solving tasks.). A median score on this index suggests a teacher who is moderately constructivist in philosophy. For this report, the index was divided roughly into quartiles, with teachers in the lowest quartile classified as "most transmission-oriented" and those in the highest quartile as "most constructivist."[6]

Teaching Philosophy by Level of Professional Engagement

Table 8 shows the percent of teachers at each level of Professional Engagement who fall into each quartile in terms of teaching philosophy. Only 3% of the Teacher Leaders fall in the most transmission-oriented quartile compared to 32% of the Private Practice Teachers, while 58% of the Teacher Leaders define their overall beliefs about good teaching in ways that suggest a strongly constructivist philosophy (compared to only 20% of Private Practice Teachers).

TABLE 8: TEACHING PHILOSOPHY BY PROFESSIONAL ENGAGEMENT

Professional Engagement	% Most Transmission-Oriented	% 2nd Quartile	% 3rd. Quartile	% Most Constructivist	% Total
Teacher Leaders	**3**	9	30	**58**	100
Teacher Professionals	14	20	26	40	100
Interactive Teachers	19	24	24	32	100
Private Practice	**32**	25	23	**20**	100
All Teachers	25	24	24	27	100

Sample: Probability and purposive samples.

Student Clientele

Are Teacher Leaders more often found in "privileged" environments, at schools where students come from advantaged homes? And are they assigned to classes that disproportionately enroll students who are already more successful academically? In other words, if Teacher Leaders face different environmental

[5] The first item contrasted the role of the teacher as learning facilitator in inquiry-based learning versus transmitter of information and procedural directions. A second item contrasted the primacy of "sense-making" with importance of transmitting the required curriculum. A third item presented the choice between believing that motivation and student interest were more important than specific subject-matter versus believing that the textbook content in history, science, math, and language skills should "drive what students study." A fourth item contrasted a teaching style with multiple activities incorporating the integration of diverse skills occurring simultaneously in the classroom with a whole-class model with short time-span tasks that "match students' attention spans and the daily class schedule."

[6] For more information on this scale and responses of the sample see TLC Report #4 (Ravitz, Becker, and Wong, 2000) —available online at www.crito.uci.edu/tlc.

conditions in their teaching, perhaps it is those factors that might account for their more constructivist orientation? On the contrary, however, we found little evidence that Teacher Leaders or Teacher Professionals are faced with different types of students than other teachers are.

The TLC data combined several different measures of school-level socio-economic advantage into a general index of socio-economic status (SES).[7] Using this index, the correlation between teacher Professional Engagement and socio-economic status was .01. Combining the probability and purposive samples, 16% of the teachers from low-SES schools—the bottom quartile—were either Teacher Leaders or Teacher Professionals whereas in the other three quartiles, the percentages ranged between 14% and 15%.

In addition to a measure of socio-economic advantage, the TLC survey had one measure of the academic ability levels of students taught by each teacher. Teachers reported prior achievement levels of students in each class they taught. (Each class could be indicated as having at least a handful of students at as many as 5 different achievement levels; e.g., one class could be coded as "below-average," "average," and "very high" if a teacher believed students were at all such levels of prior achievement.) The estimates for each class were averaged across all classes a teacher taught. On this dimension of the teaching context, Teacher Leaders did report some differences from the other three groups of teachers. In the purposive sample, Teacher Leaders were more likely to have classes of relatively high-ability students (35% did compared to 25% for the purposive sample as a whole). However, in the probability sample, the pattern was the opposite—Teacher Leaders were more likely to have students they rated as generally low achievers (20% did, versus 14% overall). For the full TLC sample, Professionally Engaged teachers did report somewhat higher average student achievement levels than other teachers, but the differences amounted to less than 10% of a standard deviation—much smaller than the differences we have been identifying for other variables.

Thus, the general pattern is that teachers of different levels of Professional Engagement serve essentially similar students in terms of both socio-economic status and student achievement. Therefore, other findings, such as the relationship between Professional Engagement and a constructivist teaching philosophy, are not likely due to the kinds of students and schools encountered by Teacher Leaders compared to the experience of other teachers.

Teaching Practice

While "teaching philosophy" expresses teachers' beliefs about good teaching, what teachers do in actual classroom settings may be quite different. In the TLC study, we asked teachers about the frequency that they engaged in more than two dozen teaching practices. In this section we address the question of whether Professionally Engaged Teachers and Private Practice Teachers employ characteristically different practices in their teaching, even among those who teach the same subjects. We present selected results about individual teaching practices, and then discuss how these individual practices are combined into indices representing general approaches to teaching.

Specific Teaching Practices and their Relationship to Teacher Professional Engagement

Table 9 shows teachers' responses to 19 survey items about teaching practices by teachers *who taught the same subject* but differed in their level of Professional Engagement. The 19 survey items come from five

[7] The SES index primarily focused on how many low-income families a school served—as measured by the percentage of students eligible for Chapter I services and the percent eligible for free or reduced lunch. For greater sensitivity at the upper-end of the distribution, we used the principal's rough estimate of the fraction of students whose parents were in professional or managerial occupations. In addition, the SES index included data on the percent of limited-English proficient students and a zip-code-based family income statistic measuring *community* SES rather than parent SES. Finally, the SES index was adjusted for the fact that elementary, middle, and high schools have different SES distributions.

survey questions which asked teachers to report about their instructional practices in *one particular class* that best represented their teaching. Each comparison is limited to teachers of one particular subject, one where the practice is fairly common. That helps in visualizing the nature of a teacher's instructional goals and what he or she might mean by using a specific teaching practice.

Professionally Engaged English teachers were more than twice as likely as Private Practice English teachers to have students work in teams to complete assignments (78% vs. 36%). They were also much more likely to have students write in a journal on at least a weekly basis (67% vs. 45%), and they were somewhat less likely to introduce a new unit by having students do introductory drills on background facts or skills. Among social studies teachers, Professionally Engaged Teachers were much more likely than Private Practice Teachers to have students work on long projects (72% vs. 33%) and to do meta-cognitive assessments of their own work (61% vs. 23%), while they were much *less* likely to lead their class in frequent whole-class recitation activities (27% vs. 61%) or to ask their students questions for the purpose of seeing if their students knew the correct answer (22% vs. 61%).

TABLE 9: SPECIFIC TEACHING PRACTICES BY SUBJECT TAUGHT: PROFESSIONALLY ENGAGED VS. PRIVATE PRACTICE TEACHERS

Teachers of This Subject	Instructional Practice	Percent Reporting Practice			
		Professionally Engaged Teachers	Interactive Teachers	Private Practice Teachers	All Teachers in That Subject
English	Students worked as a team to complete assignments for 25%+ of past five hours taught	78	60	36	50
	Students write in a journal, at least weekly	67	50	45	50
	Often use drills to introduce a unit	47	56	55	54
Social Studies	Students work on weeklong projects at least monthly	72	55	33	45
	Students do self-reflection on own work quality in writing or discussion, at least monthly	61	50	23	36
	Teacher led classroom discussion (recitation) for 25%+ of past five hours taught	27	46	61	51
	Ask questions to see if students know the correct answer (very often or always ask for that reason)	22	50	61	52
Science	Students work in small groups to jointly solve problem, at least weekly	66	49	28	41
	Ask questions to have students relate work to own experiences (very often or always ask for that reason)	74	65	40	53
	Students write essay explaining their thinking or reasoning, at least monthly	62	47	47	50
Math	Students work on problems with no obvious solution, at least monthly	54	56	35	43
	Ask questions to elicit student ideas and opinions (very often or always ask for that reason)	60	69	54	58
	Ask questions to see if students have done their homework (very often or always ask for that reason)	29	40	47	43
Elementary	Students decide on procedures for solving problems and discuss their different procedures and results, at least monthly	67	54	37	48
	Introduced current unit by having students discuss the topic among themselves in small groups	62	46	39	45
Computer	Ask questions to get students to justify and explain their reasoning (very often or always ask for that reason)	75	47	55	56
	Students make a product that will be used by someone else, at least monthly	43	36	26	34
Vocational & Fine Arts	Students demonstrate their work to an outside audience, at least monthly	56	29	18	27
All Subjects and Levels	Students do hands-on or laboratory activities, at least weekly	64	61	44	52

Professionally Engaged science teachers were almost twice as likely as Private Practice science teachers to ask students questions in order to get students to relate their school work to their own personal experiences (74% vs. 40%) and they were more than twice as likely to have students work in small groups on a weekly basis to collectively solve a problem (66% vs. 28%). Secondary math teachers falling into the Professionally Engaged group were more likely than Private Practice math teachers to report that they had students work on problems with no obvious solution (54% vs. 35%), but clearly *less* likely to report that they asked students questions in order to see if they had done their homework (29% vs. 47%). Professionally Engaged elementary teachers (grades 4-6) were substantially more likely to have students

decide on procedures for solving problems and more likely to introduce their current unit by having students discuss the topic in small groups.

Differences were also found for teachers of non-academic subjects. For example, among teachers of computer classes, many more Professionally Engaged Teachers than Private Practice Teachers said that at least monthly they had students make a product to be used by someone else (43% vs. 26%). Finally, among vocational education and fine arts teachers, those who met the criteria to be designated as Professionally Engaged were more than three times as likely to have students demonstrate their work to an outside audience as were Private Practice Teachers of the same subjects (56% to 18%).

Again, we should point out that these differences were not necessarily the strongest ones in the data. Data were purposely examined only for *one* subject-matter area for each survey item—albeit an area where differences, if they existed, were likely to be most visible. Some of these differences apply across-the-board as well, as suggested by the last row in Table 9. That row shows that across teachers of all subjects, those who were the most Professionally Engaged were half-again as likely to say that their students did hands-on or laboratory activities on at least a weekly basis as did Private Practice Teachers (64% vs. 44%).

Pedagogy Index: An Emphasis on Transmission vs. An Emphasis on Knowledge Construction

How should we understand these differences? Based on our extensive exploratory factor analyses, it is clear that almost all of the teaching practices we examined fall along a continuum from a "direct instruction" approach to teaching to an approach based on an underlying knowledge-construction conception of teaching. Moreover, this dimension of teaching practice is highly correlated with the traditional versus constructivism dimension of teaching philosophy that we discussed earlier in this paper.

Based on the factor analysis results, an index of Constructivist Pedagogy was constructed for each teacher based on their scores on 27 item prompts from five survey questions. Practices whose frequent use reflected instead a direct instruction approach were scored in reverse direction.[8] The alpha reliability for this index was .86. The index was standardized separately for each subject-matter group of teachers, so as not to allow differential subject-matter relevance of the survey items to affect teachers' scores. In addition to using the specific scores on this Constructivist Pedagogy Index, the index was divided roughly into quartiles, with teachers in the lowest quartile classified as "direct instruction-oriented" based on the way they described what they did on a regular basis in a specific, current classroom context.

Professional Engagement and Constructivist Teaching Practice

As suggested by our results on individual survey items, when we combine all 27 practices into an index contrasting transmission-oriented practices with knowledge-construction ones, Professionally Engaged teachers turn out to be much more constructivist in practice than are Private Practice Teachers. Just as with teaching philosophy, a clear majority (57%) of the Teacher Leaders fall in the quartile that most reflects a knowledge construction approach to teaching while only 2% of the Teacher Leaders are located in the direct instruction quartile. In contrast, among Private Practice Teachers, twice as many fall into the most direct-instruction-oriented quartile as fall into the most knowledge-construction-oriented quartile. (See Table 10.)

[8] For more information on this scale and responses of the sample see TLC Report #4 (Ravitz, Becker, and Wong 2000)—available online at www.crito.uci.edu/tlc.

TABLE 10: CONSTRUCTIVIST PEDAGOGY BY PROFESSIONAL ENGAGEMENT

Professional Engagement	% Direct Instruction	% 2nd Quartile	% 3rd Quartile	% Knowledge Construction	% Total
Teacher Leaders	**2**	16	25	**57**	100
Teacher Professionals	11	20	23	47	100
Interactive Teachers	16	22	29	33	100
Private Practice	**33**	28	23	**16**	100
All Teachers	24	25	25	26	100

Sample: Probability and purposive samples.

The relationship between Professional Engagement and constructivist teaching practice is quite strong across teachers of every subject-matter category analyzed in the TLC survey. Table 11 summarizes this finding by presenting the average Constructivist Pedagogy score for Professionally Engaged Teachers, Interactive Teachers and Private Practice Teachers, separately for seven subject-matter groups.

TABLE 11: MEAN CONSTRUCTIVIST PEDAGOGY, BY SUBJECT TAUGHT AND PROFESSIONAL ENGAGEMENT

	Professionally Engaged Teachers	Interactive Teachers	Private Practice Teachers	Total
English	.64	.31	−.31	.00
Social Studies	.99	.24	−.34	.01
Science	.62	.24	−.32	.00
Math	.60	.34	−.26	.00
Computer, Business, & Vocational	.61	.11	−.34	.00
Other secondary	.47	.36	−.30	−.02
Elementary	.58	.20	−.32	.00
All Teachers	.63	.25	−.31	.00

Sample: Probability and purposive samples.

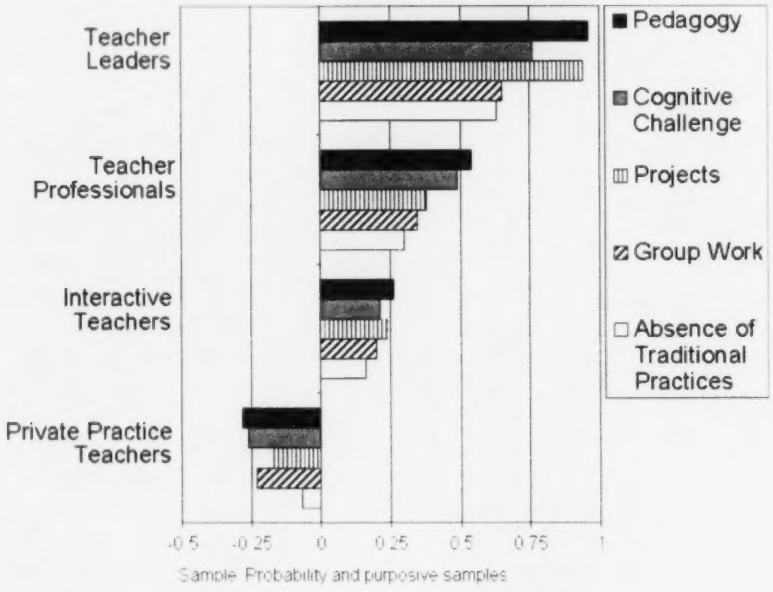
For all seven subject-matter categories, the scores for Professionally Engaged Teachers were more than two-thirds of a standard deviation higher, suggesting that they are far more constructivist in their teaching than are Private Practice Teachers of the same subject. The largest differences are in the field of Social Studies, where Professionally Engaged Teachers scored an average of 1.35 standard deviations higher in the direction of constructivist practice than do Private Practice Teachers.

Components of Constructivist Pedagogy

Our data analysis confirmed the relative uniformity of the contrast between direct instruction and knowledge-construction pedagogies. It also indicated, however, that individual practices form clearly interpretable clusters of similar types of practices. Exploratory factor analysis suggested four empirically derived sub-components, which upon further reflection appear to represent two major overriding dimensions—(A) an emphasis on cognitively challenging tasks as opposed to routine low-level exercises; and (B) an emphasis on active engagement in learning versus a more limited and passive role for students. The "active learning" dimension of constructivist practice sub-divides into three empirically identifiable elements: (1) the use of student projects; (2) small group work; and (3) an *in*frequent use of direct instruction activities. The "cognitive challenge" aspect also can be classified into several elements (reflective writing activities, teacher questions calling for deep thinking, problem-solving tasks, and organization of classroom time to promote meaning-making among students) but these are more highly correlated with one another than with the elements of "active learning" and so are best analyzed as a single component.

Figure 1 shows that on all four of these components of Constructivist Pedagogy, as with the full index as a whole, Teacher Leaders demonstrate the most constructivist teaching practices; Teacher professionals, the next most; and Private Practice Teachers, the least. Although we found that more Professionally engaged teachers assign all types of constructivist activities more often than other teachers do, this was especially true of the use of student projects. Teacher Leaders scored nearly one full standard deviation above the mean score for all teachers in the TLC sample in their use of student projects.

FIGURE 1: CONSTRUCTIVISM OF TEACHING PEDAGOGY (INCLUDING SUBSCALES) BY LEVEL OF PROFESIONAL ENGAGEMENT (Z-SCORES)



Pedagogical Change

In addition to asking teachers about their current teaching practices, we also asked 50% of the teachers about the ways that their teaching practice had changed over the past three years.[9] This retrospective self-assessment involved 16 separate items that asked about increased or decreased use of practices associated with constructivist teaching[10] or with traditional teaching.[11] Two subsets of eight items each were used with different teachers (i.e., one-fourth of the total sample answered one set; another one-fourth answered the other). The two short subsets of items (the 8 items asked to each group of teachers, each on a 4-point scale) produced indices with alpha reliability (.66 and .58) lower than the index of (current) Constructivist Pedagogy discussed above, but for our exploratory purposes they produced an adequate measure.[12] The

[9] Several questions in the TLC survey were asked of a subset of the sample in order to gather information on a wider range of topics.

[10] The "constructivist change" items asked about increases in the following teaching practices: having multiple activities occur simultaneously during class, having student interest governing lesson topics, evaluating student products rather than tests, a llowing themselves to be "taught" by students, having students teach one another, having students explore topics on their own, having students revise their prior work, having students make and investigate their own predictions, use of long projects, use of group work, and having students write essays.

[11] The items asking about traditional practices asked about direct instruction, close monitoring of student work, giving students rewards for doing well, use of textbooks generally, and having students answer questions from textbooks.

[12] The traditional practice items were all reverse-scored. The reliability of the indices could have been improved by removing the items measuring increased use traditional practices (3 in one subset; 2 in the other), but their in clusion lessened the impact of acquiescence response style on the indices, thereby providing greater balance.

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two 8-item indices asked to different subsets of respondents were combined and then categorized into four levels from "substantial constructivist change" to "little or no change or change towards a more traditional practice."

Changes in Pedagogy by Professional Engagement

Teacher Leaders and Teacher Professionals were much more likely to report having made substantial changes in their own pedagogy towards a more constructivist practice than were Private Practice Teachers. For example, 41% of the Teacher Leaders appear to have made substantial changes in many of the areas we asked about (or some change in most areas). In contrast, only 11% of the Private Practice Teachers reported that level of change during the past three years (Table 12). Thus, not only are Professionally Engaged Teachers more constructivist in philosophy and in current practice than are teachers involved in little or no professional activity, but they are also more likely to report substantial movement towards a more constructivist practice during the past three years.

TABLE 12: EXTENT OF RECENT CHANGE TOWARDS CONSTRUCTIVIST PEDAGOGY BY PROFESSIONAL ENGAGEMENT

	Increase in Constructivist Teaching Practices Over Past 3 Years				
Professional Engagement	% Little or no change; (or change to traditional practice)	% Change in a few areas	% Change in many areas	% Substantial change in many or some change in most areas	% Total
Teacher Leaders	19	11	29	40	100
Teacher Professionals	23	18	26	33	100
Interactive Teachers	24	24	35	17	100
Private Practice Teachers	37	24	28	11	100
All Teachers	31	23	30	16	100

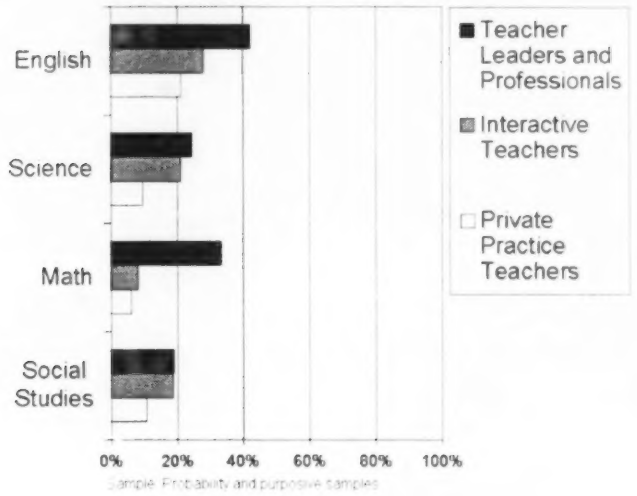
Computer Use

We turn now to a discussion of teachers' use of computers. Our central questions are whether teachers who are professionally engaged use computers more frequently than other teachers, and whether they use computers in ways that reflect their more constructivist orientation. Our principal focus is on instructional use by students during class time—how frequently teachers ask students to use computers, what types of software they have students use, and their educational objectives for student computer use. In addition, we employ a more comprehensive measure of teacher involvement with computers, one that incorporates teacher professional uses and their own technical expertise as well as their use of computers in instructional activities with students.

Relationship Between Professional Engagement and Computer Use

In nearly every subject-area of instruction, Teacher Leaders and Teacher Professionals are more likely to have their students use computers on a regular basis during class time than are Private Practice Teachers. For most subjects, they are also more likely than "Interactive Teachers" (the intermediate category of Professional Engagement) to give students regular (i.e., weekly) computer activities. Figure 2 shows that the small number of Teacher Leaders and Professionals who teach mathematics (11% of all math teachers in the sample) are more than five times as likely to assign computer work weekly as Private Practice math teachers. The differences for the other academic subjects are smaller, but Professionally Engaged English and science teachers are twice as likely as Private Practice Teachers of the same subjects to assign computer work on a frequent basis.

FIGURE 2: PERCENT OF TEACHERS WHO USE COMPUTERS WITH STUDENTS WEEKLY, BY SUBJECT



Professionally Engaged Teachers use every type of software more than Private Practice Teachers. Even when only teachers who use computers for instruction are considered, the greater the teacher's professional engagement, the more frequently do students use a given type of software. Figure 3 demonstrates this finding through a graph of the average ratio of software use between computer-assigning Professionally Engaged Teachers and Private Practice Teachers, showing that ratio for all ten types of software studied.[13,14] Even software towards the left end of Figure 3's "x-axis"—such as word processing software, CD-ROMs, and even drill-oriented game software—are used more frequently by Professionally Engaged Teachers than by Private Practice Teachers—even ignoring those teachers who do not use computers.

Figure 3 also shows that the greatest *differences* between Professionally Engaged Teachers and Private Practice teachers are in the former group's use of electronic mail, multimedia authoring software, and presentation software. Professionally Engaged Teachers use that software to enable students to communicate with other people and to produce products for an audience—activities closely associated with constructivist pedagogy. Not surprisingly, then, when teachers who used computers for instructional purposes were asked about their three most important objectives for using computers, Professionally Engaged Teachers selected more constructivist objectives than did the other groups of teachers. They were more likely than the other teachers who use computers in their classroom to have students use them to communicate with other people, analyze data, and learn to work collaboratively. They were *less* likely to use computers with the goal of having students learn computer skills, master basic academic skills, or learn to work by themselves. The differences are not as great as in our findings about software. Nevertheless, the Teacher Leaders, in particular, are twice as likely as Private Practice Teachers to have

[13] Teachers responded about frequency of software use for 10 types of software. For each type, they indicated whether students in any of their classes used that type of software in "no lessons," "1-2 lessons," "3-9 lessons," or "10+ lessons." These were translated into scores of 0, 1, 3, and 8 respectively, representing roughly proportionate levels of total activity, taking into account the likely direction of bias in each answer (i.e., the likely mean true score). The ratio between the two groups of teachers is merely the ratio of the mean scores on this index.

[14] This and subsequent analysis in this section excludes teachers of computer classes and business education classes because in those fields use of computers is nearly mandatory. This figure also excludes teachers who do not use computers with their students at all.

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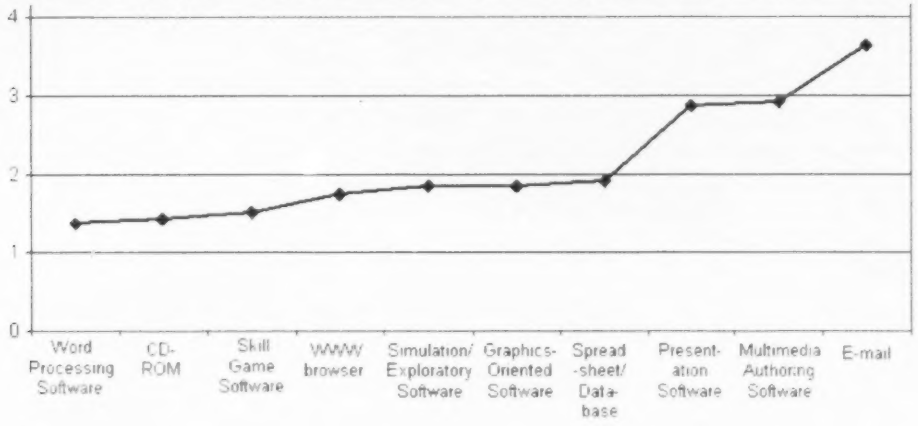
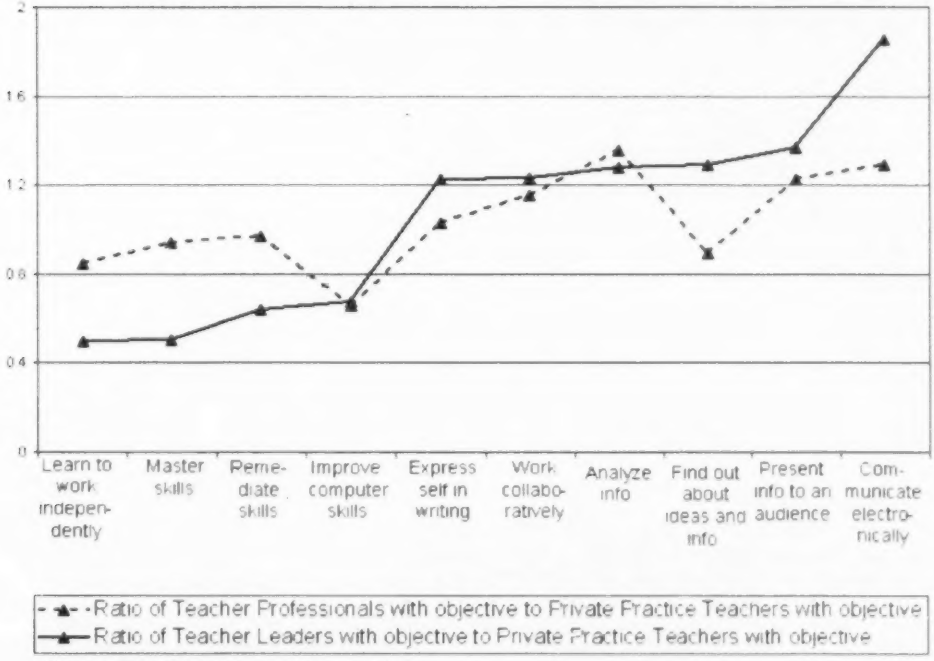
students use computers in order to communicate electronically and only half as likely to have them use computers for skills mastery purposes. (See Figure 4.)

FIGURE 3: RATIO OF (STUDENT) SOFTWARE USE BY PROFESSIONALLY ENGAGED TEACHERS TO USE BY PRIVATE PRACTICE TEACHERS, AMONG COMPUTER-ASSIGNING TEACHERS



Note: Probability and purposive samples. Excludes computer and business teachers and teachers of all subjects who do not use computers with their students at all.

FIGURE 4: COMPARING OBJECTIVES FOR COMPUTER USE OF TEACHER PROFESSIONALS AND TEACHERS LEADERS TO OBJECTIVES OF PRIVATE PRACTICE TEACHERS (RATIOS OF PERCENTAGES OF TEACHERS SELECTING THAT OBJECTIVE)



Sample: Probability and purposive samples.
Note: Excludes computer and business teachers and teachers of all subjects who do not use computers with their students at all.

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Exemplary Computer Users

The preceding evidence makes it clear that Professionally Engaged Teachers use a wider variety and more complex software with students than Private Practice Teachers do. They report objectives for student use of computers that go beyond learning using technology to teach technical skills or to simply reinforce memory. Those findings suggest that Professionally Engaged Teachers are more expert in using computers to facilitate complex academic work by students and may be more accomplished at integrating computer technology into their own professional lives. To examine in a more comprehensive way the extent that Professionally Engaged Teachers might differ from other teachers in their involvement with computers, we used factor analysis to identify a group of teachers we call "Exemplary Computer Users."

We input into the factor analysis the data on the:

- Frequency of instructional use of each of 10 categories of software.
- Frequency and variety of teachers' professional use of computers.
- Degree of technical expertise they report in using computers and different computer platforms.
- Type and degree of access to computers and related technologies at work and home.
- Whether students used computers for each of several types of complex, integrative projects.
- Extent to which computer use has increased over the past five years, in several different ways.

Factor analysis of all these different indicators of teachers' involvement with computers produced three factors, which we labeled "Constructivist Instructional Use," "Frequent Simple Uses," and "Professional Use and Expertise." The factor Constructivist Instructional Use, for example, was most influenced by how frequently a teacher had students use email, presentation software, web browsers, multimedia authoring software, and complex projects using computers. The Frequent Simple Use score was most influenced by a teacher's use with students of word processing, skill games, and frequent use of computers in general. A high score on Professional Use and Expertise indicates a high number of self-reported computer skills, a sense of expertise on both Mac and Windows platforms, and the use of a wide variety of professional computer applications (e.g., accessing lesson materials from the Internet, using digital cameras for lesson preparation, corresponding with parents, and posting student work on the Web). Teachers' scores on these three dimensions were combined, and, using a judgmental process, cutoff points were chosen that, in combination, selected 10% of all teachers as Exemplary Computer Users.[15] Similar percentages (9% to 12%) at each school level and in subject-areas (other than computer and business education) were identified as exemplary.[16]

Yet when we disaggregate teachers according to their level of Professional Engagement, rather remarkable differences appear. In particular, Teacher Leaders were 10 times as likely as Private Practice Teachers to be designated as Exemplary Computer Users (See Figure 5.) Forty percent of Teacher Leaders were also Exemplary Users, compared to only 4% of Private Practice Teachers. About one-fourth of Teacher Professionals were classed as Exemplary, six times as many as among Private Practice Teachers. Of the three component factors of this measure, Teacher Leaders are most different from other teachers in having students use constructivist-oriented tool software (mean z-score of +.88), and least

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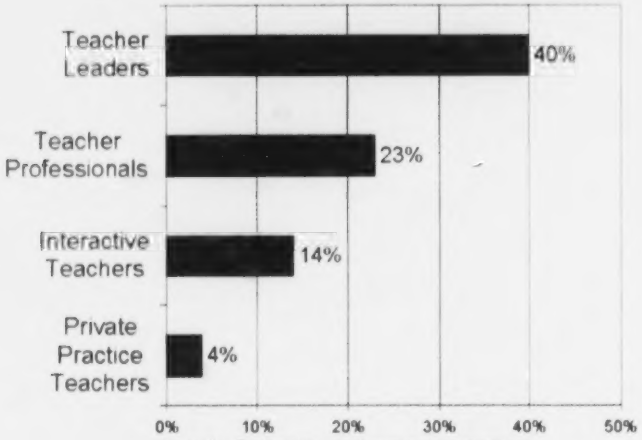
[15] To operationalize the dichotomous construct "Exemplary Computer User," we employed a cutoff score for each of the three factors, setting the cutoff point according to a judgment of how important each dimension was for the underlying construct. Specifically, teachers were judged to be Exemplary Computer Users if they were .25 st andard deviations above the mean on Constructivist Instructional Use, .25 standard deviations above the mean on Professional Use and Expertise, and no lower than .25 standard deviations below the mean on Frequent Simple Uses. These cutoff points represen ted the top 24% of teachers on Constructivist Instructional Use, the top 41% on Professional Use and Expertise, and the upper 54% on Frequent Simple Uses. To meet the criterion for being labeled an "Exemplary Computer User," a teacher needed to pass all t hree cutoff points.

[16] In looking at differences between Professionally Engaged teachers and other teachers in whether they were exemplary computer users, we employed a second factor analysis that differed from the first only in omitting computer education teachers and business education teachers. Because it is almost mandatory that teachers of such subjects be involved with computers, we didn't want the fact that more computer education and business education teachers are Professionally Engaged (see abov e, page 15) to explain differences in computer use between Professionally Engaged and other teachers.

different from other teachers in terms of frequent use of simple software (still more than one-half standard deviation higher than average, z=+.52). On Professional Use and Expertise, their superiority was extremely high (z=+.67), but not as high as on Constructivist Instructional Use.

FIGURE 5. PERCENT EXEMPLARY COMPUTER-USING TEACHERS, BY LEVEL OF PROFESSIONAL ENGAGEMENT



Sample: Probability and purposive samples.
Note: Excludes computer education and business education teachers.

Of all of the ways in which Professionally Engaged and Private Practice teachers might differ—in their backgrounds, teaching responsibilities, teaching philosophies, and teaching practices—none of them produced differences on the order of magnitude of this measure of Exemplary Computer Use. This suggests that there is a very strong connection between teacher leadership and sophisticated use of computers, in both teaching and professional life. Teacher Leaders are much more likely than the typical teacher to have incorporated a wide variety of computer applications into their instructional practice and they are much more likely to have become competent users of computers themselves.

The magnitude of this association suggests that several different causal forces are operating—that teachers who act in professional ways are more motivated to master new technologies and more easily see the utility of computers in their work; that accomplishment in using technology in student lessons and in class preparation motivates teachers into sharing with peers their new skills; and, in a complementary way, that teachers seeking to learn to exploit computers in their work also seek out professional contacts as a means of attaining those skills. The huge association between computer expertise and professional leadership among teachers also helps to explain why the excitement about using computers one sees at professional meetings of teachers does not translate into widespread improvement across-the-board in teachers' use of technology: the participants at such conferences are professionals who are exploiting computers in their work, but they are an unrepresentative subset of purveyors of their craft. The real challenge for such leaders is to transfer their excitement and expertise to their peers who lack the same interest for involving themselves either in professional activities or in learning to master the application of computer resources to their instructional and work tasks.

Socio-Economic Differences in Professionally Engaged Teachers' Use of Computers and in Their Pedagogy

Differences in Extent of Computer Use

We have already shown that schools serving students from poorer economic (low-SES) backgrounds have as many Professionally Engaged Teachers as do schools serving more economically advantaged students. (See above, page 15.) However, other analysis of the TLC data has shown that, for all teachers considered together, teachers in low-SES schools use computers with students in more traditional ways than teachers in higher-SES schools. Teachers in low-SES schools are more likely to have students use computers more for routine skills practice (particularly in mathematics) and to learn to work independently, and they are less likely to have students use computers to make presentations, do analytic work, or write (Becker, 2000). When computers are used frequently in low-SES schools, they are used more often in low-level mathematics courses and less often in science and computer education classes. However, those findings are true when *all* teachers are considered together, but Professionally Engaged Teachers are only a small minority of that population. The question we address here is whether this general finding holds true for Professionally Engaged Teachers in low-SES settings. Are they also less likely to be Exemplary Computer Users, and are they less constructivist pedagogically than Professionally Engaged Teachers in higher-SES schools?

Until this point in the analysis, we have been able to combine the TLC probability sample schools and the TLC purposive sample schools because patterns have been similar. That is, in *both* the probability and purposive samples, Professionally Engaged Teachers are much more likely than other teachers to be Exemplary Computer Users and to be more constructivist in philosophy and in teaching practice than are Private Practice Teachers.[17] However, that similarity in patterns across the two types of samples is no longer the case when one also takes into account school-level socio-economic status. There is a completely different relationship between computer use and school SES and between constructivist pedagogy and school SES among Professionally Engaged Teachers who teach in the reform-minded and technology-infused schools in the TLC purposive sample than there is for Professionally Engaged teachers in the probability sample.[18] Consequently, in order to draw conclusions about typical patterns, the following analysis is limited to the probability sample alone.

In that nationally representative sample, Professionally Engaged Teachers from the highest SES quartile are much more likely to be Exemplary Computer Users (37%) than are Professionally Engaged Teachers in the middle two quartiles combined (21%). In addition, Professionally Engaged Teachers from the *lowest* SES quartile are much *less* likely than those from schools serving more advantaged students to be Exemplary Computer Users (11%)—although they are still more than three times as likely to be so as all *other* teachers in low-SES schools (3%). (See Figure 6.)

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[17] For example, 22% of Professionally Engaged teachers in the probability sample are Exemplary Computer Users, and 30% of those in the purposive sample are—both much higher percentages than around found among the remaining teachers in their respective samples (7% and 8%, respectively). Similarly, both groups are much more likely than other teachers in their sample to be in the top quartile of teachers nationally in terms of constructivist beliefs and constructivist teaching practices—although, again, the differences are greater between Professionally Engaged teachers and other teachers in the purposive sample. (See Appendix Table A-2.)

[18] In particular, among Professionally Engaged teachers in the reform and high-technology schools of the purposive sample, those who teach in schools with below-average SES are just as likely to be Exemplary Computer Users and they are even more constructivist in philosophy and teaching practice than are Professionally Engaged teachers who teach in higher-than-average SES schools in the purposive sample. The teachers in the reform-involved and technology-infused schools of the purposive sample will be the central focus of a future report in this series.

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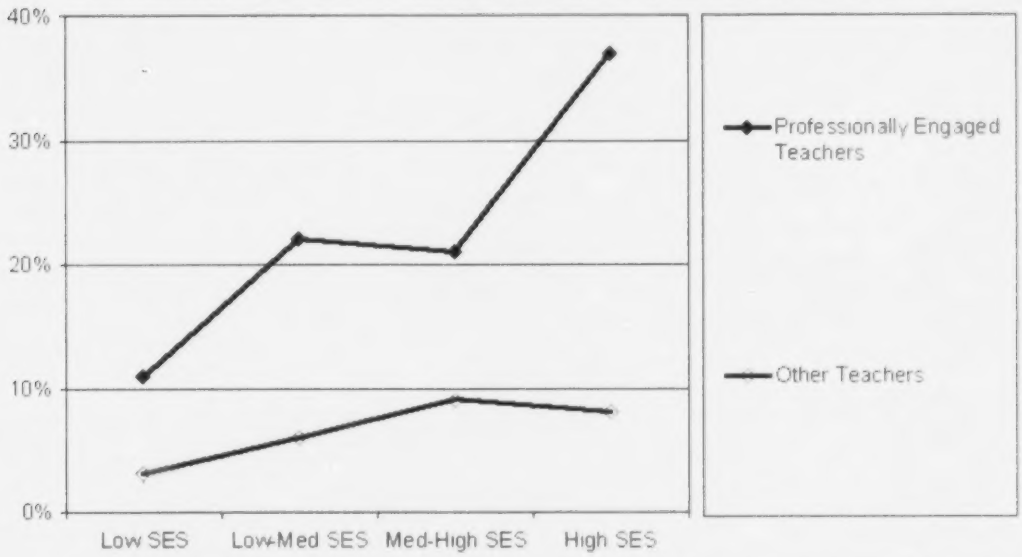
FIGURE 6: PERCENT EXEMPLARY COMPUTER USER,
BY PROFESSIONAL ENGAGEMENT LEVEL AND SCHOOL SOCIO-ECONOMIC STATUS



Sample: All teachers in probability sample. The number of Professionally Engaged teachers surveyed across the four SES groups are, respectively 80, 98, 101, and 100.

Of course, one reason why Professionally Engaged Teachers in low-SES schools may have less expertise with computers is that they have less access to computers at their school. Other TLC analysis (Anderson and Ronnkvist, 1999) has shown that although schools in poor communities have nearly as many computers per-capita as other schools, in most other ways—particularly Internet-related measures—teachers in low-SES schools have less technology accessible to them. There is also less time and money available for supporting teachers' use of computers in schools with a more disadvantaged student body.

To investigate the effects of access to technology and technology support on the SES-differences in Professionally Engaged Teachers' use of computers, we conducted several multiple regression statistical analyses. First, we computed an index of Teachers' Involvement in Computers based on the three statistical factors (Constructivist Instructional Computer Use, Frequent Simple Uses, and Professional Use and Expertise) employed in our identification of teachers as Exemplary Computer Users. Then we computed an "access-adjusted" version of this index, by first predicting an expected level of technology involvement based solely on a teacher's access to technology. School access to technology was indicated by the following information:

- The number of computers in a teacher's classroom.
- Teacher overall access to school-supplied technology-related resources.
- School-level adequacy of high-quality computer and Internet access.
- School-level estimate of the time per teacher spent on training and support.
- Percent of all school technology investments going for support (rather than hardware or software).

The adjusted index indicated a teacher's level of involvement in using computers after taking these access variables into account.[19] Several different analyses were conducted because adding additional technology

[19] It should be pointed out that three access variables (number of classroom computers, teacher's home computer access, and school-supplied technology resources) also contributed to the three factors going into the Teachers ' Involvement in Computers

access variables as controls reduced the number of cases for which we had complete data. Overall, we estimate that close to one-half of the difference in exemplary computer use by Professionally Engaged Teachers in high-SES versus low-SES schools is due solely to differences in how adequately their school is able to provide them with computer-related resources. (See Appendix Table A-3.)

Another large part of the explanation could come from differences in how many of their students have computers at home. Exemplary technology-using teachers in schools with more advantaged students are in a better position to expropriate students' home computer resources than equally capable teachers who work with less advantaged students. Students who have home computers come to school with more computer skills, and teachers with such home-advantaged students can use computers during class without having to take valuable classroom time to teach technical skills. In the portion of the TLC probability sample of Professionally Engaged Teachers for which we have student home computer use data,[20] only 8% of those teaching in the poorest one-fourth of the schools reported that one-half or more of their students used computers at home (or other places besides school) to do work for their class. In contrast, more than 60% of Professionally Engaged Teachers at schools in the top-SES quartile reported that level of home computer use for school work.

Finally, Professionally Engaged Teachers in high-SES schools are also more likely to have a home computer and modem themselves, and to have had one for at least four years, than are equally professionally-oriented teachers who work in low-SES schools.[21]

Overall, then, although it is true that among Professionally Engaged Teachers, those who teach in higher-SES schools are much more likely to be Exemplary Computer Users, it is not likely that this is because they have different interests in using computers—they simply have less opportunity to do so. Their schools provide fewer computer-related resources such as personnel support and Internet connections, their students have fewer computer resources at home, and they themselves are less likely to have computers and Internet connections at home. These conclusions are supported by the following findings about how these two groups of Professionally Engaged Teachers are otherwise quite similar in their pedagogy.

Differences in Philosophy and Teaching Practices

In contrast to what we found regarding teachers' computer use, there are few differences in the teaching practices of Professionally Engaged Teachers who work in high-SES and low-SES settings. In both cases, they are significantly more constructivist than other teachers. This is true with respect to the active learning strategies such as group work and student projects and also with respect to cognitively challenging instructional practices. There is a tendency for Professionally Engaged Teachers to have more constructivist teaching philosophies in high-SES schools than in low-SES schools, but in terms of actual teaching practices, their constructivism is almost indistinguishable between the two very different socio-economic settings (See Figure 7).

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index, although their direct contributions were relatively minor. By controlling for them again with this adjusted index, we make sure that their impact is completely removed from the Teachers' Involvement in Computers variable.

[20] This data, as others in this section, come only from the probability sample of teachers. However, because the question about students' home computer use was asked to only some teachers in the TLC sample (just those whose students used computers during class and then only a 50% sample of those teachers), the numbers of teachers in this comparison is quite small —27 Professionally Engaged teachers from low-SES schools and 40 from high-SES schools.

[21] In particular, comparing Professionally Engaged teachers at schools in the high SES quartile with those teaching in the lowest SES schools, 82% of the former have a computer and modem at home compared to 65% of the latter. In addition, 81% of those teaching in high-SES schools have had a home computer for at least 4 years compared to 53% of the Professionally Engaged teachers in low-SES schools.

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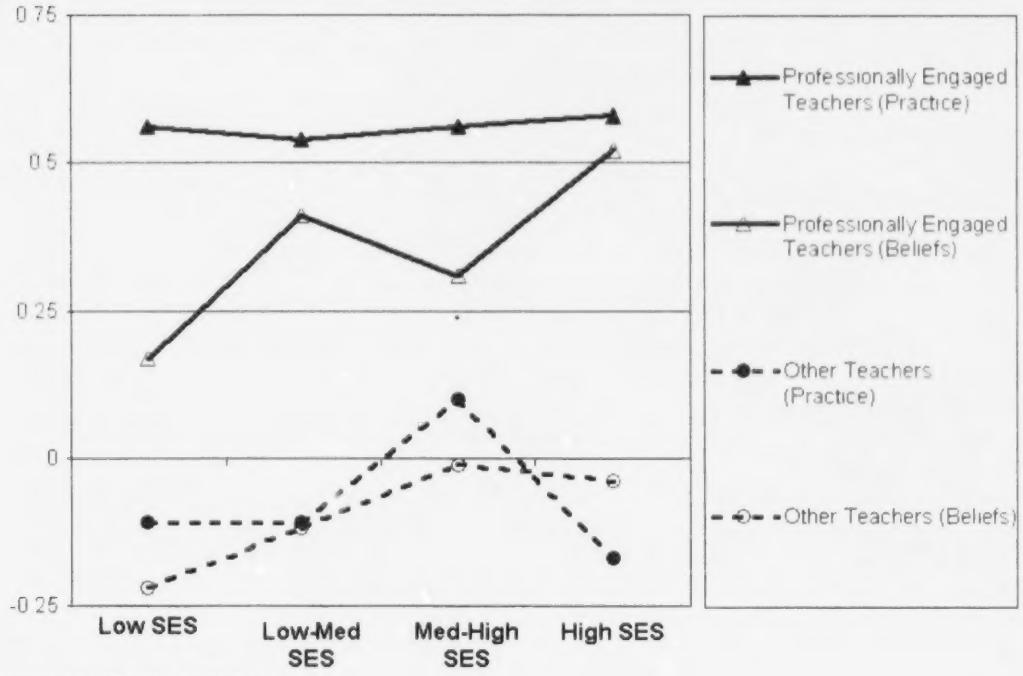
FIGURE 7: AVERAGE TEACHING PHILOSOPHY AND TEACHING PRACTICE SCORES BY SCHOOL SOCIO-ECONOMIC STATUS, FOR PROFESSIONALLY ENGAGED AND OTHER TEACHERS



Sample: Probability Sample only.

The findings in this section can be summarized in the following way: Despite the fact that exemplary use of computers is strongly associated with constructivist beliefs and teaching practices, and despite the fact that, across all SES settings, Professionally Engaged Teachers are much more likely than other teachers to hold constructivist beliefs and to employ constructivist teaching practices, only in the higher-SES schools do Professionally Engaged Teachers make exemplary use of computer resources. This difference appears to be primarily the result of low levels of access to computer technologies in low-SES school settings—they are less present throughout the school, training and support for computer use is less available, and both teachers and students are less likely to have computers at home. At the same time, for teachers who are not professionally engaged, having more school and home computer resources (i.e., the situation in high-SES schools) does not translate into higher levels of Exemplary Computer Use. Computer resources are useful only when there is a pedagogy that warrants their use, and Private Practice Teachers, as we have seen, are much less likely than other teachers to have the requisite pedagogical viewpoint and to employ the kinds of instructional strategies that would make computer resources valuable to their practice. This suggests that a conceptual divide is as much a problem in our wealthier schools as is the digital divide for poorer schools.

IMPLICATIONS AND CONCLUSION

Our findings suggest that teachers who are not drawn into the professional community—those who have isolated themselves in their classroom—are teaching in ways that contrast sharply with teachers who engage in a continual teaching and learning interactions. And the ways in which those two groups of teachers differ pedagogically demonstrate a symmetry between the way in which they enact the role of a teacher and the way in which they structure their classroom for their students. Teachers who are isolated from their peers engage in teaching in which students work alone on externally prescribed curricula. Teachers who work in collaborative settings and who take the initiative to affect their teaching environment create the same settings for their students—collaborative work and student-initiated activity.

Policy-makers who suggest changing the relationship of teachers to the larger education community as a way of changing what happens within the classroom will find that these results support their efforts. By one measure, 20% of teachers play a significant leadership role among their peers, including those who have taught a college-level course for credit and published their work. These teachers who take a leadership role in field of education, sharing their work with others in the field, are much more likely to be teachers who place their students in leadership roles in the classroom. They encourage collaborative, project-based learning in which students are required to present their work to their peers.

And the inverse relationship is also true. Those teachers who do not participate in any leadership activities in the educational community are more likely to be the teachers who focus on traditional methods of delivery of information, on direct instruction. They do not place a high value on collaborative knowledge building in the classroom or for themselves in the educational community. The teachers who played a minimal role in the larger educational community are the teachers who do not expect this behavior from their students. The role of the student in their classrooms is to listen, learn, and repeat. They are more likely to be concerned with helping students learn the right answers that can be found in the back of any textbook and less likely to encourage students to ask questions for which there is no single "right" answer.

These findings also show that the most professional engaged teachers—teachers who are leaders in their communities—are exploiting computers in a constructivist manner. Their use of computers with students is not limited to gaining computer competence, but extends to involvement in cognitively challenging tasks where computers are tools used to achieve greater outcomes of students communicating, thinking, producing, and presenting their ideas. Data on software use and objectives for computer use suggest that Teacher Leaders recognize the features of technology that grant students access to a broader community and knowledge base beyond the walls of the classroom. They are able to incorporate the use of computers into student activity more effectively than teachers who fail to participate in their professional community.

This comes as no surprise. Meaningful integration of computers and instruction is a difficult task, one that requires contact, collaboration, and support from professional peers, the school organization, and the educational community as a whole. If the inferences we draw from this data are correct, the current focus on testing students and holding teachers accountable is likely to engender a system in which teachers do the same thing to students. If, on the other hand, what we want from our schools is thoughtful and creative problem-solving and constructive, independent thinking, the most effective way to achieve these goals may be to design a system where teachers are encouraged to be thoughtful and creative problem solvers in the design of learning environments for students.

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APPENDIX

TABLE A-1: SUBSCALE SCORING BY CATEGORY OF PROFESSIONAL ENGAGEMENT

	Teacher Leaders	Teacher Professionals	Interactive Teachers	Private Practice Teachers
Number of areas in which "high" standard was met (0 to 3)				
3	100%	--	--	--
2	--	49%	22%	0%
1	--	43%	56%	15%
none	--	8%	23%	85%
Total	100%	100%	100%	100%
Number of areas in which at least a "medium" standard was met (0 to 3)				
3	100%	100%	--	--
2	--	--	80%	11%
1	--	--	20%	50%
none	--	--	0%	39%
Total	100%	100%	100%	100%
By Area:				
Within-School Interactions				
High	100%	31%	24%	2%
Medium	--	69%	33%	18%
Below	--	--	43%	80%
Total	100%	100%	100%	100%
Beyond-School Contacts				
High	100%	59%	44%	8%
Medium	--	41%	27%	26%
Below	--	--	28%	65%
Total	100%	100%	100%	100%
Leadership Activities				
High	100%	52%	30%	5%
Medium	--	48%	21%	12%
Below	--	--	49%	83%
Total	100%	100%	100%	100%

TABLE A-2: HIGHLY CONSTRUCTIVIST TEACHERS AND EXEMPLARY COMPUTER USERS BY PROFESSIONAL ENGAGEMENT AND TYPE OF SCHOOL SAMPLE

	% Exemplary Computer User	% in Top Quartile on Constructivist Philosophy	% in Top Quartile on Constructivist Pedagogy
Probability Sample			
Professionally Engaged	22	38	46
Other	07	23	23
Purposive Sample			
Professionally Engaged	30	50	53
Other	08	25	21

TABLE A-3: EFFECTS OF SCHOOL-BASED ACCESS TO TECHNOLOGY ON THE DIFFERENCE IN TEACHERS' INVOLVEMENT IN COMPUTERS BETWEEN HIGH-SES AND LOW-SES SCHOOLS, FOR PROFESSIONALLY ENGAGED TEACHERS AND OTHER TEACHERS

Professional Engagement Level and School Socio-Economic Status (SES)	Teachers' Involvement in Computers Index Score: Mean score without adjustments			Mean score (and difference from unadjusted score, identical cases) adjusted for Technology Hardware Access* (*A*)	Mean score (and difference) adjusted for Technology Hardware Access and School-Based Support for Teachers' Technology Use** (*B*)
	All cases	(*A*) cases	(*B*) cases		
Professionally Engaged Teachers	(n=379)	(n=288)	(n=170)		
Top Quartile SES	1.18	1.11	1.28	.91 (–.20)	1.00 (–.28)
2nd Quartile SES	.70	.62	1.03	.59 (–.03)	.89 (–.15)
3rd Quartile SES	.66	.81	.81	.86 (+.05)	.86 (+.05)
Bottom Quartile SES	.14	.34	.22	.45 (+.11)	.41 (+.19)
% reduction in difference between top and bottom quartiles for identical cases	--	--	--	40%	44%
Other Teachers	(n=1784)	(n=1325)	(n=753)		
Top Quartile SES	–.01	.00	–.06	.05 (+.05)	.02 (+.08)
2nd Quartile SES	–.12	–.25	–.15	–.20 (+.05)	–.14 (+.01)
3rd Quartile SES	–.25	–.25	–.33	–.05 (+.20)	–.08 (+.25)
Bottom Quartile SES	–.39	–.36	–.32	–.24 (+.12)	–.20 (+.12)
% reduction in difference between top and bottom quartiles for identical cases	--	--	--	20%	14%

*Technology Hardware Access variables included number of classroom computers, school-provided teacher technology resources and school-level technology density indicators.

**School support for technology use measured by school-level data on hours of training provided per capita and percent of technology investment going for support and training

Sample: Probability sample.